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Effect of Different Levels of Neem Coated Urea on Productivity of Finger Millet (*Eleusine coracana* L. Gaertn)

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Abstract— *A field experiment was conducted during the kharif season of 2025 at Krishi Vigyan Kendra (KVK), Anini, Dibang Valley, Arunachal Pradesh, to evaluate the effect of different levels of neem-coated urea (NCU) on productivity of finger millet (Eleusine coracana L. Gaertn.) cv. VL Mandua 379. The experiment was laid out in a Randomized Block Design with seven treatments and three replications. Data were analysed via analysis of variance (ANOVA), and treatment effects were evaluated at 5% level of significance. Application of NCU significantly influenced all yield parameters. The treatment* T_2 *(100% NCU) recorded superior performance in yield attributes, including number of seeds per finger (428)* $[F(6,12) = 4.80, p < 0.05]$*, test weight (3.20 g), finger weight (7.77 g) and finger length (9.77 cm). Similarly, biological yield (7.37 t* ha^{-1}*) and economical yield (2.85 t* ha^{-1}*) were significantly higher under* T_2 *compared to other treatments. Harvest index also differed significantly among treatments* $[F(6,12) = 19.77, p < 0.001]$*. In conclusion, using 100% neem-coated urea increases yield, economical quality and profitability of finger millet. Such a result advocated the use of NCU as a means to improve nitrogen use efficiency in agriculture, although more multi-location testing is desirable.*

Keywords*— *Finger millet, Neem-coated urea, yield.

I. INTRODUCTION

Finger millet (*Eleusine coracana* L. Gaertn) is a significant nutritious crop that is grown in rain-fed and hilly areas in India including Eastern Himalayan region. It is considered a high-nutritional-value crop due to greater calcium, dietary fiber and amino acids content. Although it thrives in poor fertility status and is climate resilient, the yield of finger millet is low due to poor nutrient management, particularly low nitrogen use efficiency. Nitrogen has a key role in crop growth, productivity and quality. But use of conventional nitrogen fertilizers like urea is often accompanied with significant losses due to volatilization, leaching and denitrification, resulting in poor efficiency of nitrogen use and environmental problems. In regions with high rainfall such as Arunachal Pradesh, these losses are exacerbated, leading to poor crop performance and economic losses.

Neem-coated urea (NCU) has been used successfully to enhance nitrogen use efficiency by prolonging nitrogen release and minimising losses. The coating helps in the slow release of nitrogen and acts as an inhibitor of nitrification and so matches the nitrogen supply to plant needs, so improving nitrogen use efficiency. In many studies, it has been reported that the application of NCU not only increases yield but also grain quality and prevents losses to the environment.

However, limited information is available on the performance of graded levels of neem-coated urea on finger millet in the agro-climatic conditions of the Eastern Himalayan region. Therefore, the present investigation was undertaken to evaluate the effect of different levels of neem-coated urea on productivity, nutritional quality, and economic returns of finger millet.

II. MATERIALS AND METHODS

Site of Experimentation: In *Kharif* 2025, the experiment was carried out in KVK Anini, Dibang Valley, Arunachal Pradesh (28.79° N latitude and 95.90° E longitude), at an altitude of 1600–1968 m above mean sea level. The experimental site falls under the Eastern Himalayan agro-climatic zone and is characterized by humid subtropical climatic conditions with high rainfall and moderate temperature. These conditions are favorable for finger millet cultivation under rainfed conditions but also prone to nitrogen losses through leaching, making it suitable for evaluating the efficiency of neem-coated urea (NCU). The soil was acidic (pH = 3.65) and sandy loam.

Experimental Design and Crop Management: The experiment was carried out in a Randomized Block Design (RBD) comprising seven treatments with three replications. Finger millet variety VL Mandua 379 was used as the test crop due to its adaptability and suitability for hill regions. The field was prepared to a fine tilth through ploughing and leveling, followed by layout as per the experimental design. The treatments consisted of graded levels of nitrogen applied through neem-coated urea, including a control without nitrogen application. The treatment structure included T_0 (control), T_1 (110% recommended nitrogen through NCU), T_2 (100% recommended nitrogen through NCU), T_3 (90% recommended nitrogen through NCU), T_4 (80% recommended nitrogen through NCU), T_5 (70% recommended nitrogen through NCU), and T_6 (60% recommended nitrogen through NCU). Neem-coated urea was top dressed at the designated levels. Random allocation of treatments was done within each replication to reduce the error of experimentation and to compare the effects of treatments. All plots received enriched organic manure (25 kg). Top dressing with neem-coated urea was applied 20 days after transplanting as per the treatments applied. The seeds were first raised in a nursery and transplanted 30 days later with a spacing of 25cm × 15cm. The same crop management practices, such as irrigation, weeding and pest management, were followed for all the treatments for crop growth.

TABLE 1
DETAIL OF THE EXPERIMENT TREATMENT

	Treatments
T_0	Control
T_1	110% Neemcoated urea
T_2	100% Neemcoated urea
T_3	90% Neemcoated urea
T_4	80% Neemcoated urea
T_5	70% Neemcoated urea
T_6	60% Neemcoated urea

Observations Recorded: Yield attributes such as number of seeds per finger, finger length, finger weight, and test weight were noted from randomly selected plants in every plot.

Economical yield and biological yield were recorded at harvest and expressed in t ha^{-1}. Harvest index (%) was calculated.

All the categories of recorded observations are mentioned in table 2. along with their purpose.

TABLE 2
CATEGORIZATION OF RECORDED OBSERVATIONS

Category	Parameters Included	Purpose
Yield Attributes	Seeds per finger, Test weight, Finger weight, Finger length	Determine yield potential
Yield Parameters	Biological yield, Economical yield, Harvest index	Measure overall productivity

Statistical Analysis: The experimental data were subjected to analysis of variance appropriate for RBD, following standard procedures. The significance of treatment effects was tested using the F-test at the 5% level of probability. Treatment means were compared using Critical Difference (CD), and Standard Error of Mean (SEm) was calculated to assess precision. The total variation was partitioned into components due to treatments, replications, and error, as described by Snedecor and Cochran.

III. RESULTS AND DISCUSSION

The ANOVA) revealed that graded levels of neem-coated urea (NCU) exerted a statistically significant influence ($p < 0.05$) on all major yield attributes, and yield parameters of finger millet. The non-significant effect of replication for most traits indicates minimal experimental variability, confirming that the observed differences were primarily due to treatment effects. Similar reliability of field experiments under controlled conditions has been reported by Snedecor and Cochran (1994).

3.1 Yield Attributes:

The response of yield attributes to different levels of nitrogen applied through NCU were strong and statistically significant as indicated by ANOVA on seeds per finger [F(6,12) = 4.80], test weight [F(6,12) = 29.50], finger weight [F(6,12) = 35.03], and finger length [F(6,12) = 77.69]. The size of the F-values, especially the test weight, finger weight and finger length indicates that variation induced by treatment was significantly larger than experimental error and is a strong and consistent treatment effect. T_2 (100% NCU) treatment always produced the highest values in all attributes such as seeds per finger (428), test weight (3.20 g), finger weight (7.77 g), and finger length (9.77 cm), whereas the control (T_0) treated values at the lowest. Table 3 shows all the values graphically represented by Figure 1.

The relatively high F-values in the current study may be explained by the fact that the experimental uniformity was maintained well, the treatment was applied and the variability of the environment was minimal, which reduced the error mean square and increased the ability to detect treatment differences. This is also supported by low standard error of difference (SEd), a range of ±29.77 of the seeds per finger, a range of ±0.05 of the test weight and a range of ±0.19 of the finger length, which all indicate high precision of the means of the treatments. Additionally, critical difference (CD) values with probability level of 5% proved the statistical robustness of treatment comparisons. The differences between T_2 and other treatments exceeded the respective CD values (e.g., CD = 10.36 for seeds per finger, 0.12 for test weight, 0.68 for finger weight, and 0.41 for finger length), establishing that the superiority of T_2 was not only numerically higher but also statistically significant.

The only difference between T_2 and other treatments was not only numerically greater but also statistically significant. The enhancement of yield attributes under T_2 can be ascribed to optimum and maintenance availability of nitrogen, which improves vegetative growth, reproductive development and assimilate translocation. Nitrogen abundance enhances a greater chlorophyll abundance and photosynthetic capacity, which all lead to an increase in spikelet fertility and cost-effective formation. Kumar *et al.* (2023) have reported similar findings where the urea coated with neem showed better yield attributes in finger millet. Interestingly T_1 (110% NCU) was not superior in performing compared to T_2 despite the high nitrogen dose.

This implies that the benefits of nitrogen application in excess of the recommended amount does not proportionately increase the yield attributes, and may actually diminish the effectiveness of nitrogen use. Nitrogen excess can cause luxuriant vegetative development at the cost of reproductive development resulting in inefficient assimilate partitioning. This tendency promotes the law of diminishing returns and is matches with the results of Pradhan *et al.* (2015) and Meena *et al.* (2021).

3.2 Yield Parameters:

Both economical yield and biological yield were significantly influenced by NCU levels and ANOVA demonstrated strong treatment effects on both economical and biological yield. The extremely large value of the F-value of biological yield indicates a very strong treatment effect with very small experimental error, indicating that nitrogen levels played a decisive role in biomass production. The highest biological yield (7.37 t ha^{-1}) and economical yield (2.85 t ha^{-1}) was reported under T_2 (100% NCU), followed by T_3 (90% NCU) and T_4 (80% NCU) whereas control treatment reported the lowest yields. Table 3 presents all the values, and the graph (Figure 1) illustrates the data.

TABLE 3
EFFECT OF DIFFERENT LEVELS OF NEEM-COATED UREA ON YIELD AND YIELD ATTRIBUTES

Treatments	Number of Seeds per Finger	Test Weight (g)	Finger Weight (g)	Finger Length (cm)	Biological Yield (t ha^{-1})	Economic Yield (t ha^{-1})	Harvest Index (%)
T_0 – Control	300	2.6	3.82	6.17	5.56	2.25	38.74
T_1 – 110 % NCU	391.67	2.8	6.5	7.13	6.16	2.5	40.67
T_2 – 100 % NCU	428	3.2	7.77	9.77	7.37	2.85	42.42
T_3 – 90 % NCU	361.67	3	7.37	8.63	6.71	2.62	41.05
T_4 – 80 % NCU	347.67	3.15	7.23	8.5	6.35	2.54	40.25
T_5 – 70 % NCU	323.33	3.02	6.83	8.8	6.26	2.53	40.18
T_6 – 60 % NCU	310	2.82	6.7	8.03	6.18	2.48	39.67
F-Test	S	S	S	S	S	S	S
SEd (±)	29.77	0.05	0.31	0.19	0.1	0.06	0.36
CD (P = 0.05)	10.36	0.12	0.68	0.41	0.21	0.14	0.8

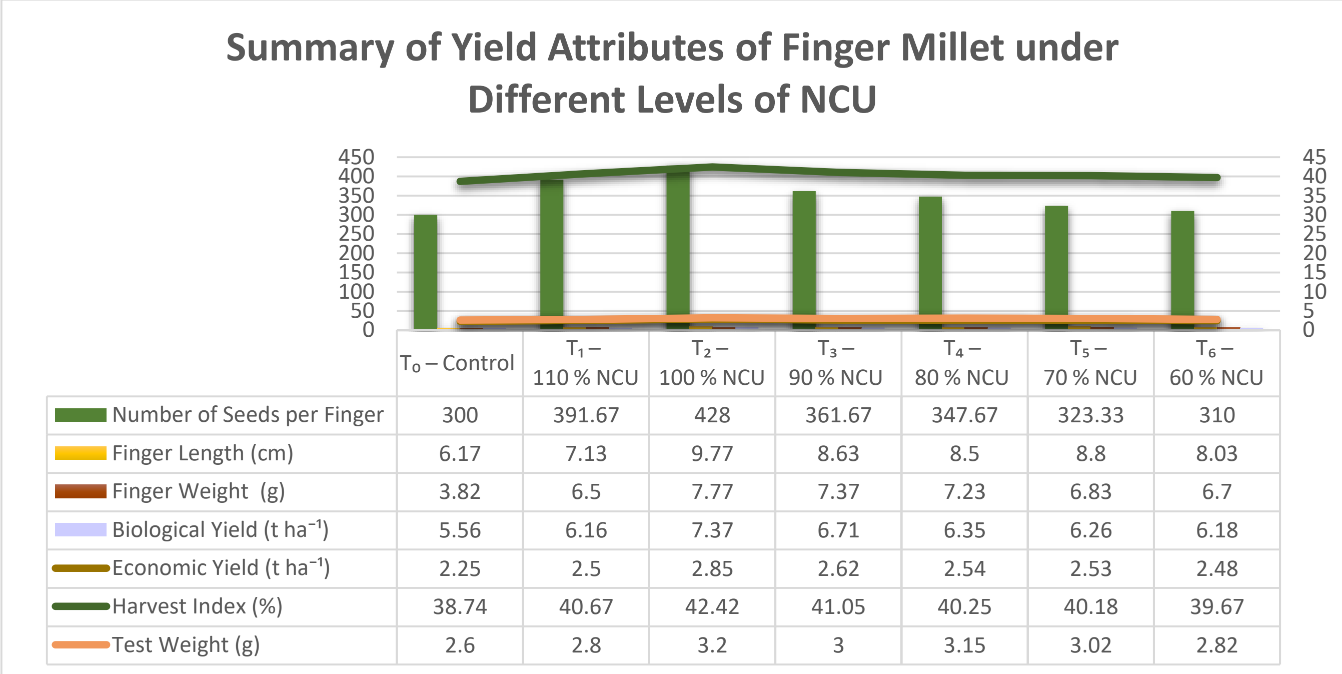

FIGURE 1: Effect of different levels of neem coated urea on yield and yield attributes of finger millet

The high F-values of yield parameters further confirm that the differences in the treatments were not randomly found but a direct cause of the nitrogen management practices. The fact that the SEd of biological yield and economical yield are very low (±0.10 and ±0.06) supports the precision of these estimates. Moreover, the calculated values of CD (0.21 in the case of biological yield and 0.14 in the case of economical yield) prove that the yield benefits of T_2 over other treatments were statistically significant as the observed differences were above the level that is required to be considered significant. This supports the accuracy of the treatment ranking, and confirms that T_2 was clearly better in the above experimental conditions. This improvement in yield under T_2 can be explained by two factors; balanced supply of nutrients and higher efficiency of the process of converting assimilates into the economic yield. In addition, the calculated CD values (0.21 for biological yield and 0.14 for economical yield) demonstrate that the yield advantages of T_2 over other treatments were statistically significant, as the observed differences exceeded the threshold required for significance.

The Neem-coated urea controls the release of nitrogen, and the availability of nutrients and crop demand, subsequently reducing the losses due to leaching and volatilization. These results align with Sharma and Singh (2021), who found better nitrogen use efficiency and yield when NCU is applied. The lower yields recorded at the high (110%) and low nitrogen levels further stress the need to optimize the use of nitrogen in agriculture. Harvest index also demonstrated significant variation

[F(6,12) = 19.77), highest value at under T_2 (42.42%). The low SEd (±0.36) and CD value (0.80) further indicate that the differences in harvest index were accurate and statistically significant which are indicative of optimal partitions efficiencies of optimal nitrogen supply. This has also been observed in cereal crops, which are fed balanced nitrogen nutrition. Similar observations have been reported in cereal crops under balanced nitrogen nutrition (Surekha *et al*., 2023).

IV. CONCLUSION

The current study has revealed that the use of NCU in management of nitrogen in finger millet under Eastern Himalayan conditions has had significant effects on the yield, quality, and economic payoffs of finger millet. Out of the treatments, the use of 100 percent recommended nitrogen using neem-coated urea (T_2) always registered higher performance in yield. The outcome shows that the optimal supply of nitrogen enhances efficiency in the utilization of nutrients, reduces losses, and increases the partitioning of assimilate to economic yield. Sub-optimal and excessive levels of nitrogen led to poor performance, and therefore, balanced fertilization is crucial. Thus, the use of 100 percent NCU is suggested as an effective and cost-effective measure towards sustainable production of finger millet. It is recommended that further multi-location research is done to confirm these findings in different agro-climatic conditions.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this research paper.

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